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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 85/TY00L90/WO	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/IB2004/001829	International filing date *(day/month/year)* 04.06.2004	Priority date *(day/month/year)* 12.06.2003
International Patent Classification (IPC) or national classification and IPC F02D19/08, F02D41/00, F02P5/152		
Applicant TOYOTA JIDOSHA KABUSHIKI KAISHA et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 8 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11.01.2005	30.09.2005
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized Officer Röttger, K Telephone No. +31 70 340-3948

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/001829

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1, 3-14	as originally filed
2, 2a, 2b	received on 11.01.2005 with letter of 11.01.2005

Claims, Numbers

1-14	received on 11.01.2005 with letter of 11.01.2005

Drawings, Sheets

1-16	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-14
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-14
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-14
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: US 2002/139111 A1 (TAKI MASAHIRO ET AL) 3 October 2002

D2: US-A-5 109 821 (IIDA KAZUMASA ET AL) 5 May 1992

Claims 1 and 12

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and shows:

A spark ignition internal combustion engine in which a high-octane fuel and a low-octane fuel are mixed so that a mixing proportion is variable by fuel mixture means and a mixed fuel is supplied into a combustion chamber, wherein a standard octane number is set in accordance with an operation state of the spark ignition internal combustion engine, and a first mixing proportion between the high-octane fuel and the low-octane fuel is adjusted so as to achieve the standard octane number, and a reference ignition timing corresponding to the standard octane number is set, and knocking measurement means is provided in the spark ignition internal combustion engine, and the knocking measurement means measures a state of occurrence of knocking during a predetermined operation state of the spark ignition internal combustion engine.

The subject-matter of claim 1 differs from this known engine in that mixing proportion estimation means are provided and that the mixing proportion estimation means determines a deviation value between a second mixing proportion between the high-octane fuel and the low-octane fuel really supplied into the combustion chamber and the first mixing proportion, the deviation value being set based on the measured state of occurrence of knocking, and estimates the second mixing proportion between the high-octane fuel and the low-octane fuel based on the deviation value.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to estimate the real mixing proportion of the fuel.

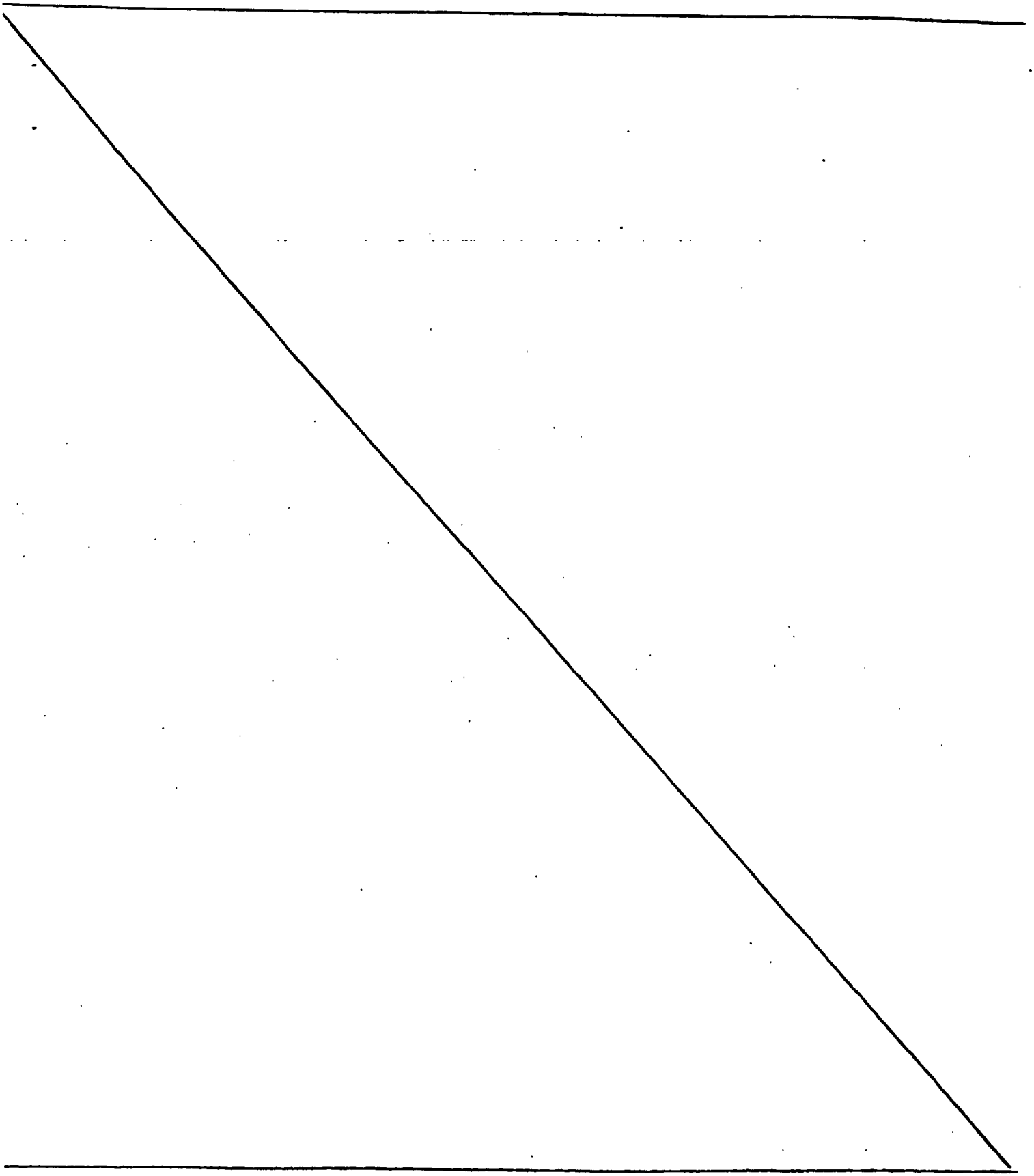
The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:
None of the other cited documents show the estimation of a deviation value between the real mixing proportion and the target value based on the occurrence of knocking.
It is already known from D2 to estimate the blend ratio of a fuel based on the occurrence of knocking in an internal combustion engine when the blend ratio sensor fails. The skilled man however would not consider the teaching of D2 for the estimation of the second mixing proportion because the estimation of the blend ratio is done by adaptive correction of the last measured blend ratio.

The above argumentation applies as well to the corresponding method claim 13 which therefore is also new and inventive.

Dependent Claims
Claims 2-11 and 14 are dependent on claim 1 or claim 13 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

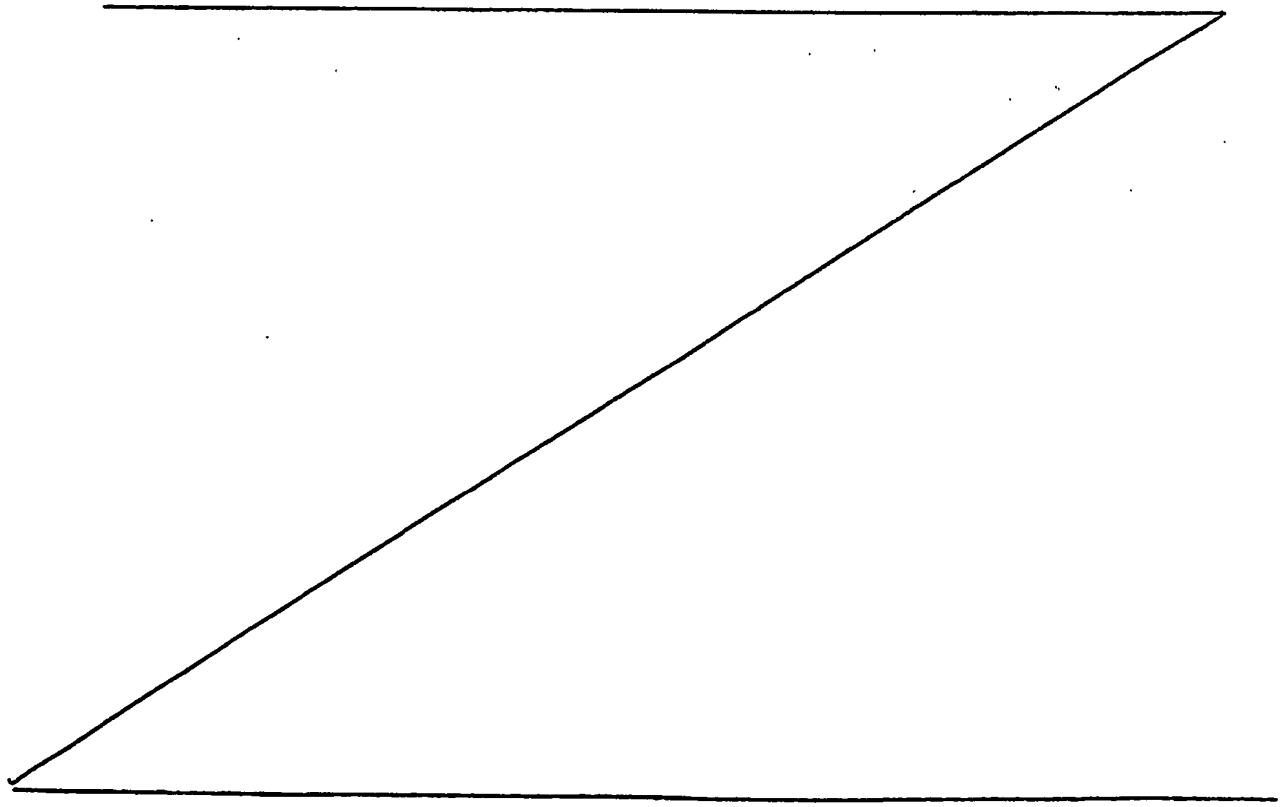
Re Item VIII
Apparatus claim 1 is defined using many method steps (e.g. "a standard octane number is set ...") rather than by the means and this causes confusion as to the category of the claim (Article 6 PCT).

the case of a large deviation in the mixing proportion, the apparatus may be incapable of achieving a practical effect.



With Document US 5 109 821 an engine control system for compensation of a detection value of a blend ration sensor with a detection value of a nock sensor or causes trouble detecting means to detect a failure of the blend ratio sensor and memories the blend ratio before the failure as an assumed blend ratio is known.

Document US 2002/139111 A1 shows a spark ignition internal combustion engine in which a high-octane fuel and a low-octane fuel are mixed so that a mixing proportion is variable by fuel mixture means and a mixed fuel is supplied into a combustion chamber, wherein a standard octane number is set in accordance with an operation state of the internal combustion engine, and a first mixing proportion between the high-octane fuel and the low-octane fuel is adjusted so as to achieve the standard octane number, and a reference ignition timing corresponding to the standard octane number is set, and knocking measurement means is provided in the spark ignition internal combustion engine, and the knocking measurement means measures a state of occurrence of knocking during a predetermined operation state of the spark ignition internal combustion engine.



SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide a spark ignition internal combustion engine in which a high-octane fuel and a low-octane fuel are mixed and supplied to the engine, and the mixing proportion between the high-octane fuel and the low-octane fuel in the mixed fuel can be determined.

[0006] In accordance with a first aspect of the invention, a spark ignition internal combustion engine in which a high-octane fuel and a low-octane fuel are mixed so that a mixing proportion is variable by fuel mixture means and a mixed fuel is supplied into a combustion chamber, is characterized in that a standard octane number is set in accordance with an operation state of the spark ignition internal combustion engine, and a first mixing proportion between the high-octane fuel and the low-octane fuel is adjusted so as to achieve the standard octane number, and a reference ignition timing corresponding to the standard octane number is set, and knocking measurement means and mixing proportion estimation means are provided in the spark ignition internal combustion engine, and the knocking measurement means measures a state of occurrence of knocking during a predetermined operation state of the spark ignition internal combustion engine, and the mixing proportion estimation means determines a deviation value between a second mixing proportion between the high-octane fuel and the low-octane fuel really supplied into the combustion chamber and the first mixing proportion, the deviation value being set based on the measured state of occurrence of knocking, and estimates the second mixing proportion between the high-octane fuel and the low-octane fuel based on the deviation value.

[0007] In the first aspect of the invention, the high-octane fuel and the low-octane fuel are mixed at a variable mixing proportion and supplied into a combustion chamber by the fuel mixture means. A standard octane number is set in accordance with the operation state, and the mixing proportion between the high-octane fuel and the low-octane fuel is adjusted so as to achieve the standard octane number, and a reference ignition timing corresponding to the standard octane number is set. The state of occurrence of knocking during a predetermined operation state is measured. On the basis of the measured state of occurrence of knocking, a deviation from the set mixing

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Claims

1. A spark ignition internal combustion engine in which a high-octane fuel and a low-octane fuel are mixed so that a mixing proportion is variable by fuel mixture means (13a, 13b) and a mixed fuel is supplied into a combustion chamber,
characterized in that
a standard octane number is set in accordance with an operation state of the spark ignition internal combustion engine, and a first mixing proportion between the high-octane fuel and the low-octane fuel is adjusted so as to achieve the standard octane number, and a reference ignition timing corresponding to the standard octane number is set, and knocking measurement means (10b) and mixing proportion estimation means are provided in the spark ignition internal combustion engine, and the knocking measurement means (10b) measures a state of occurrence of knocking during a predetermined operation state of the spark ignition internal combustion engine, and the mixing proportion estimation means determines a deviation value between a second mixing proportion between the high-octane fuel and the low-octane fuel really supplied into the combustion chamber and the first mixing proportion, the deviation value being set based on the measured state of occurrence of knocking, and estimates the second mixing proportion between the high-octane fuel and the low-octane fuel based on the deviation value.

2. The spark ignition internal combustion engine according to claim 1, characterized in that if the second mixing proportion is different from the first mixing proportion, an amount of the high-octane fuel and/or an amount of the low-octane fuel supplied into the combustion chamber are/is changed so that the second mixing proportion becomes substantially equal to the first

mixing proportion.

3. The spark ignition internal combustion engine according to claim 1 or 2, characterized in that if knocking does not occur during the predetermined operation state, the ignition timing is advanced.

4. The spark ignition internal combustion engine according to any one of claims 1 to 3, characterized in that if knocking occurs during the predetermined operation state, a proportion of the high-octane fuel is increased.

5. The spark ignition internal combustion engine according to any one of claims 1 to 4, characterized in that the knocking measurement means (10b) executes a knock control of retarding the ignition timing in accordance with a strength of knocking when knocking occurs, and the mixing proportion estimation means estimates the second mixing proportion based on an amount of retardation of the ignition timing caused by the knock control.

6. The spark ignition internal combustion engine according to claim 5, characterized in that the amount of retardation of the ignition timing caused by the knock control is corrected by an intake air temperature.

7. The spark ignition internal combustion engine according to any one of claims 1 to 6, characterized in that the fuel mixture means (13a, 13b) mixes the high-octane fuel and the low-octane fuel so as to achieve the standard octane number based on a known nominal octane number of the high-octane fuel and a known nominal octane number of the low-octane fuel.

8. The spark ignition internal combustion engine according to any one of claims 1 to 7, characterized by further comprising actual octane number detection means adapted for detecting an actual octane number of the low-octane fuel

and an actual octane number of the high-octane fuel, wherein the fuel mixture means (13a, 13b) sets a third mixing proportion between the high-octane fuel and the low-octane fuel in accordance with the operation state so as to achieve the standard octane number based on the actual octane number of the high-octane fuel detected by the actual octane number detection means and the actual octane number of the low-octane fuel detected by the actual octane number detection means.

9. The spark ignition internal combustion engine according to claim 8, characterized in that the actual octane number detection means sets a proportion of the low-octane fuel at 100% to measure the state of occurrence of knocking during the predetermined operation state, and determines the actual octane number of the low-octane fuel based on the measured state of occurrence of knocking, and mixes the low-octane fuel whose actual octane number has been determined with the high-octane fuel at a predetermined proportion, and measures the state of occurrence of knocking during the predetermined operation state, and determines the actual octane number of the high-octane fuel based on the measured state of occurrence of knocking.

10. The spark ignition internal combustion engine according to any one of claims 1 to 9, characterized by further comprising a fuel separator device (4) that separates a fuel into the high-octane fuel and the low-octane fuel, wherein the mixing proportion estimation means determines whether the fuel separator device (4) is normally operating so as to separate the fuel into the high-octane fuel having a predetermined octane number and the low-octane fuel having a predetermined octane number.

11. The spark ignition internal combustion engine according to claim 10, characterized in that, in the fuel separator device (4), a fourth mixing proportion in accordance with the operation state is set so as to attain the

standard octane number on an assumption that the separated high-octane fuel and the separated low-octane fuel have the predetermined octane numbers, and the mixing proportion estimation means determines that an operation of the fuel separator device (4) is abnormal if the deviation value between the second mixing proportion determined based on the state of occurrence of knocking and the fourth mixing proportion is greater than a predetermined criterion value.

12. The spark ignition internal combustion engine according to any one of claim 1 to 11, further comprising fuel injection means for injecting the high-octane fuel and the low-octane fuel so that a mixing proportion of the high-octane fuel and the low-octane fuel corresponds to the first mixing proportion.

13. A method for estimating a mixing proportion between a high-octane fuel and a low-octane fuel which is supplied into a combustion chamber of a spark ignition internal combustion engine, characterized by comprising the steps of:

a first step of setting a standard octane number in accordance with an operation state of the spark ignition internal combustion engine;

a second step of adjusting a first mixing proportion between the high-octane fuel and the low-octane fuel so as to achieve the standard octane number;

a third step of setting a reference ignition timing corresponding to the standard octane number;

a fourth step of measuring a state of occurrence of knocking during a predetermined operation state;

a fifth step of determining a deviation value between a second mixing proportion between the high octane fuel and the low octane fuel really supplied into the combustion chamber and the first mixing proportion,

the deviation value being set based on the measured state of occurrence of knocking; and

a sixth step of estimating the second mixing proportion between the high-octane fuel and the low-octane fuel based on the deviation value.

14. A method according to claim 13 further comprising a fuel injection step during which high-octane fuel and low-octane fuel are injected in a mixing proportion of the high-octane fuel and the low-octane fuel corresponding to the first mixing proportion.